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ECONOMIC FREEDOM AND WORLD ECONOMIC GROWTH: EVIDENCE AND IMPLICATIONS

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The purpose of this study is to explain the statistical variation in economic growth rates in a broad cross-section of countries, over the period 1980-99. This problem will be addressed within the framework of the so-called "growth-regression" approach, which seeks to explain this variation by relating economic growth to a list of potential explanatory variables. A large number of studies published since the early 1990's have been based on the so-called "neo-classical theory of economic growth," and this approach will be followed as a first approximation, though the main purpose of the paper is to evaluate the incremental explanatory power of several additional variables not usually contemplated in the conventional neo-classical approach.

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1. Introduction.

Since 1986, a group of researchers associated with the Fraser Institute have focused on the definition and measurement of an internationally comparable index of economic freedom (Easton and Walker, 1992; Gwartney, Block and Lawson, 1996; Gwartney and Lawson, 2003, 2004). This work has resulted in the development of a numerical index which, in its most recent version (Gwartney and Lawson, 2002), ranks 123 countries in terms of their degree of economic freedom, as measured by a composite of 38 indicators grouped in five major categories (size of government, legal structure, monetary and banking policy, international trade, and regulation). This composite indicator is expressed as an index number which rates each country's degree of economic freedom on a scale ranging from 1 (lowest possible score) to 10 (highest possible score). Actual values of the "Economic Freedom of the World" (EFW) index in the year 2000 ranged from a high of 8.78 (Hong Kong) to a low of 3.37 (Myanmar).[1]

One important finding of this work is that the degree of economic freedom, as measured by the EFW index, is highly correlated with both the level and the rate of growth of real per capita GDP (see Table 1). These comparisons, though striking, nonetheless suffer from two limitations: (1) they are simple, two-variable correlations, and (2) they are average results for groupings of countries. Thus, analyzing the results for countries grouped in quintiles essentially averages out much of the actual dispersion in the data, while ignoring the effect of other explanatory variables might bias the results due to an "omitted variables" effect. One main purpose of this paper is to evaluate the incremental explanatory power of the EFW index in the context of more general models of economic growth. The period chosen for study was 1980-99, and the growth-regressions were estimated for a broad cross-section of countries. (Data sources and definitions of variables are detailed in Appendix A.)

Table 1. Economic Freedom, per capita Income, and Economic Growth.

Countries Ranked by EFW Index in 2000	GDP per capita 2000 PPP (us$)	Growth rate (%), per capita GDP, 1990-2000
Bottom quintile	$2,556	–0.85
4th quintile	$4,365	1.44
3rd quintile	$6,235	1.13
2nd quintile	$12,390	1.57
Top quintile	$23,450	2.56

Source: Gwartney and Lawson (2002), p. 20, Exhibits 5 and 8.

[1]See Appendix B for a full listing of the countries covered by the EFW index as of 2000.

2. Convergence and Economic Freedom.

At first glance, the results in Table 1 seem to contradict at least some aspects of neo-classical growth models, since the high-EFW countries are not only richer than low-EFW ones, but also grow faster, contrary to the "convergence" predictions of the standard models, which imply that high-income countries will tend to have lower rates of growth due to diminishing returns on physical capital (Solow, 1956). However, these two effects are not necessarily mutually exclusive—in principle *both* effects can hold—since, as Barro and Sala-i-Martin have pointed out, the convergence effect is actually a *ceteris paribus* prediction (Barro and Sala-i-Martin, 1992; Barro, 1994; Sala-i-Martin, 1996). What the neo-classical models predict is that, *other things equal*, countries with higher initial income will have slower growth, and vice-versa.

Therefore, a direct test of the existence of both effects would be to regress the growth rate of real per capita GDP against (1) the log of initial-year PPP-adjusted per capita GDP, (2) the EFW index, and (3) a set of additional explanatory variables, as suggested by some prior theoretical framework. The convergence effect predicts that the first variable should have a negative coefficient, and the interpretation of the regression in *ceteris paribus* terms is straightforward: other things equal, (1) if two countries have the same level of economic freedom, as measured by the EFW index, the country with the higher initial income will tend to have a lower growth rate due to the convergence effect; (2) on the other hand, if two countries start out with the same income level, the country with more economic freedom will tend to grow faster.

The usefulness of the EFW index as an explanatory variable for economic growth can be evaluated by examining its performance under different model specifications. One possibility is to include EFW in a growth-regression based on what we might call the "canonical" variables of the augmented Solow growth model: initial income, investment share in GDP, a measure of population growth, and some measure of human capital (Mankiw, Romer and Weil, 1992; Knight, Loayza and Villanueva, 1993). Another option is to include EFW in a simplified version of a model recently proposed by Gallup, Sachs and Mellinger (1999), explaining per capita income growth in terms of the convergence effect and three "geographic" variables. Estimating the effect of EFW in the context of these two different models is a quite strong test of "robustness" for this variable, since it would be hard to imagine characterizations of the growth process that differ as much as these do. If it turns out that EFW is significant in *both* regressions, then one could conclude that economic freedom is indeed a significant factor in economic growth, regardless of one's basic theoretical framework.

3. Economic Freedom in a Neo-classical Growth Model.

Regressions based on the neo-classical model are reported in Table 2 (Regressions 1 to 3). The first regression uses only the variables in the basic model:

LOGGDP80 = log of PPP-adjusted per capita GDP in 1980,

INV = investment share in GDP, average for 1980-99,

FERTIL = total fertility rate, average for 1980-99, used as the measure of population growth,[2]

DSCH15 = change in "average years of schooling for the population aged 15 and over," 1980-95 (as measured by Barro and Lee, 2001), used as the human capital variable.

This model performs rather well. These four variables explain almost 59 % of the cross-country variation in economic growth over this period, all of the variables are significant and have the expected signs.

Regression 2 disaggregates DSCH15 into its male (DMALESCH15) and female (DFEMSCH15) components, and the results suggest that, at least in this sample period, it is the male component of the schooling variable that really counts in terms of economic growth.[3] Dropping DFEMSCH15 (Regression 3) yields results for the other variables that are essentially identical to those in Regression 1.

Regression 4 adds the average EFW index for each country (measured as the average of the values for 1980, 1985, 1990, 1995). Though we lose 5 observations due to missing values, the results are still quite strong. The coefficient for EFW is positive and significant, and the explanatory power increases to 68.5 %. The coefficients for the other variables are significant and quite similar to the previous results.

Regression 5 adds DEFW = change in the EFW index from 1980 to 1995. This too has a positive and significant coefficient, and increases the explanatory power to 72.6 %. This suggests that the growth-effect of economic freedom depends not only on the absolute *level* of the EFW index during any given period, but also on the direction (and magnitude) of the *change* in the index over that period.

4. Geography, Economic Freedom and Growth.

We can conclude, from Regressions 1 to 5, that economic freedom, as measured by the EFW index, adds significantly to the explanatory power of a neo-classical growth model.[4] To test the robustness of this finding with respect to changes in model specification, we

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[2]Use of the fertility rate as the measure of population growth gives a better fit in the regressions, and its coefficient is also easier to interpret. However, none of the substantive conclusions are altered by using the population growth rate instead.

[3]This confirms findings of other researchers (for instance, Barro, 2001), and may be due to the fact that in most countries men still account for the larger share of the labor-force. Even with current low female labor-participation rates, however, this result does not imply that female education has no effect at all on economic growth, since, as we will see later on, there is an important indirect effect due to the impact of female education on fertility levels (see Note 10).

[4]Easton and Walker (1997), working with *levels* of income, and Dawson (1998), working with rates of growth, applied an earlier version of the EFW index to extend the results of Mankiw, Romer and Weil (1992). Both studies confirmed that addition of an economic freedom measure increases the explanatory power of the neo-classical model.

will estimate the effect of economic freedom in the context of a growth-regression based on a totally different approach.

A series of studies directed by Jeffrey Sachs have focused on the relationship between geography and economic development (Gallup, Sachs and Mellinger, 1999; Sachs, 2000). The motivation for these studies is based on two empirical observations:

(1) Countries located in tropical regions of the world tend to be poor, whereas countries in temperate zones tend to be wealthier—a comparison of GDP per capita in countries grouped according to geographic latitude illustrates this tendency quite graphically (Sachs, 2000, Fig. 2).

(2) Countries with easy access to maritime transportation tend to be wealthier than landlocked countries. (These two tendencies are mutually reinforcing: landlocked *and* tropical countries are in double jeopardy, and tend to be the poorest of all.)

Though these studies consider a very large number of different variables, we will concentrate here on the three main location-related variables used in Gallup, Sachs and Mellinger (1999):

TROPICAR = proportion of a country's territory located in the geographic tropics,[5]

POP100KM = proportion of the country's population living within 100 kilometers of the sea coast,

LOGDIST = log of minimum distance of the country to one of three core areas of the world economy (defined as New York, Rotterdam or Tokyo).

The Gallup, Sachs and Mellinger study found that these three variables explained a large share of the cross-country variation in real income *levels* in 1950, 1990 and 1995. In addition, it was found that the effect of these variables increased through time, implying a geographic effect on *rates of growth* as well.

To test for a geographic effect on growth in the 1980-99 sample period, we first estimate Regression 6, a growth-regression based on these three variables, plus initial income (to allow for a convergence effect, i.e. the tendency for growth rates to decline as income rises). Both TROPICAR and POP100KM are significant and have the expected signs, though LOGDIST is not significant. The convergence effect, though negative, as expected, is only marginally significant. Overall explanatory power for this regression is quite low (20.6 %).

Adding EFW and DEFW to this model (Regression 7) substantially increases its explanatory power (to 50.9 %). All of the variables are significant (again, except for

[5]Tropical regions are defined as areas located between 23.5 degrees of latitude North (Tropic of Cancer) and 23.5 degrees of latitude South (Tropic of Capricorn).

LOGDIST) with the expected signs, and it is noteworthy that in this model the estimated growth-impact of economic freedom is even stronger than in the neo-classical model.

Do the geographic variables have incremental explanatory power in the context of a neo-classical model that controls for economic freedom? What would be the effect, in other words, of adding the three geographic variables to Regression 5? In this exercise (Regression 8) both POP100Km and LOGDIST are non-significant, though TROPICAR does appear to have a significantly negative effect on economic growth. Thus, there does seem to be some basis for the view that geography has an effect on economic growth, though perhaps not as strong as some initial studies seemed to imply.

5. Results and Interpretation.

Regression 9 summarizes the end-result of this statistical exercise: a neo-classical model, augmented by the economic freedom variables and one geographic variable (TROPICAR), statistically explains roughly 78 % of the observed variation in the reduced sample, which is quite impressive, given the nature of the dependent variable. What conclusions can be drawn from this analysis?

For one thing, the results clearly vindicate the neo-classical growth model: the variables we have used to measure the "canonical" neo-classical variables are all significant, and their signs are consistent with that model's predictions. Though not unexpected, given what we know from prior work in this field, the results are nonetheless "not uninteresting," since, though some neo-classical predictions seem quite obvious and common-sensical, others are much less so. The results for investment, for instance, conform to common intuition, even in the absence of a formal theoretical model, since it seems pretty obvious that countries that save/invest a large share of GDP should grow faster than countries that save/invest little. Likewise, we don't need a formal growth model to know that countries that invest heavily in human capital can expect to grow faster than countries that do not. On the other hand, the neo-classical predictions regarding "convergence" and the effects of demographic growth, though strong implications of the model, are much less intuitively obvious, so the fact that they do actually show up in the data serves to strengthen our confidence in the model as a representation of the fundamental processes involved in economic growth.[6]

The results also suggest, however, that the neo-classical model is not the whole story, and that there is scope for extension in this basic model in at least two directions: (1) allowing for cross-country differences in the degree of economic freedom, and (2) allowing for the effect of geography. None of these factors is considered explicitly in formal neo-classical growth models, though both were found to have incremental explanatory power vis-à-vis the neo-classical variables.

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[6]In this regard, it is interesting to note that, statistically, these two effects are in fact the strongest elements in the relationship: their t-values are larger that those of any other of the variables in Regression 9. Therefore, the negative effect of these two variables would show up in any regression based on a subset of this particular list of variables, since we know from a theorem due to Leamer (1975) that dropping any regressor from a multiple regression can never reverse the sign of a non-deleted regressor if the latter's (absolute) t-value is larger than that of the deleted regressor.

Regarding the estimated regression coefficients:

(1) LOGGDP80 — The negative value for this coefficient confirms the "conditional convergence" prediction of the Solow growth model: other things equal, a country's economic growth rate will tend to decline as its income level rises. A one point increase in LOGGDP80 is associated, on average, with a decline of about 2 percentage points in the annual growth rate of per capita GDP.

(2) INV — The value for this coefficient implies that, on average, a one point increase in the investment/GDP ratio can be expected to increase the annual growth rate of per capita GDP by about 0.09 percentage points. Thus, if two countries are identical in every relevant respect, except that one country invests 20 % of its GDP whereas the other invests only 10 %, the difference in their annual growth rates will be, on average, about 0.9 percentage points.[7]

(3) FERTIL — This coefficient has a negative value, confirming the neo-classical prediction regarding population growth. The fertility rate is measured in terms of children per woman, and the value of the coefficient implies that, other things equal, a unit increase (one additional child) in the average fertility rate will decrease a country's annual growth rate by about 0.9 percentage points. Quite apart from its implications in terms of the Solow growth model, this is a matter of considerable empirical interest, since the debate over the economic consequences of population growth is by no means settled.[8] To be sure, this does not necessarily imply an endorsement of neo-Malthusian alarmism, since an overall worldwide *decline* in fertility levels has been noticeable for quite some time (Maudlin, 1981; Coale, 1983; Wilson, 2001). A continuation of this trend, given our empirical results, would actually provide some grounds for optimism regarding growth prospects in less developed countries. In any case, our results clearly support the view that high fertility levels are, other things equal, a negative factor in terms of per capita income growth. In the Solow model this negative effect arises from the fact that, for a given investment rate, higher population growth implies, in the long-run, a lower capital-labor ratio. The results confirm this theoretical prediction, but our empirical estimate probably also picks up two other fertility-related effects that are not explicitly developed in formal growth models:

a) A factor that is often ignored in income comparisons between developed and under-developed countries is that younger workers tend to be less productive than older ones (since they have less on-the-job experience), so average levels of productivity are affected by changes in the age-structure of the population. High-fertility countries have high birth rates, which implies that they tend to have "young" populations, and hence, lower average productivity than countries with lower birth rates. For explorations of some of these issues see Sarel (1995) and Crenshaw, Ameen and Christenson (1997).

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[7]It is tempting to interpret this as an estimate of the average incremental rate of return on physical capital (about 9 % per annum). As Barro and Lee (1994) note, however, "some assumptions about depreciation are required for this calculation" (p. 278).

[8]Kelley (1988) provides a good survey of the voluminous literature on these issues.

b) An interesting "two-way causation" between fertility and human capital arises from the fact that children in smaller families tend to have, on average, more years of schooling. This is partly an income-effect (higher income families tend to have less children), but not entirely, since the family-size effect on schooling levels shows up even after controlling for income.[9] Thus, declining fertility can be expected to boost per capita income growth through its effects on human capital.

(4) DMALESCH15 — Recall from Regression 2 that the female component of the schooling variable turned out to be non-significant, which is why all successive regressions have employed the male component only.[10] We have used the *change* in average years of schooling, rather than the *level* of schooling, since this is what seems to correspond to an investment concept for human capital. (Notice that in the case of physical capital, what actually affects economic growth in the Solow model is not the *stock* of physical capital, but the rate of *investment*, which is the *change* in the capital stock. Higher *stocks* of capital, both physical and human, will of course be associated with higher income *levels*, but not necessarily with higher growth rates.) The value for this coefficient implies that each one-year increase in the level of adult schooling over the sample period has been associated, on average, with an increase of about 0.3 percentage points in the annual growth rate of per capita GDP. This too is an interesting result, since the empirical contribution of education to economic growth has recently been questioned.[11]

(5) EFW and DEFW — The coefficient on EFW measures the level effect of cross-country differences in the EFW index, and its estimated value implies that, other things equal, countries with greater economic freedom will have higher growth rates: each one point difference in the EFW index is associated, on average, with a difference of about 0.8 percentage points in the annual growth rate of per capita GDP. Moreover, it matters whether economic freedom is increasing or decreasing through time: the coefficient on DEFW implies that each one point *increase* in the EFW index over the sample period has been associated, on average, with an increase of about 0.5 percentage points in the growth rate of per capita GDP.[12] The mechanism involved is probably quite complex, since the

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[9]See Knodel, Havanon and Sittitrai (1990) for a discussion of evidence from Thailand, a country that has experienced extremely rapid fertility declines in recent decades.

[10]In Note 3 we pointed out that this does not imply that female schooling has no impact at all on economic growth. In fact, there is a indirect positive impact, since it is well known that female schooling has a significant effect on fertility levels—see, for instance, Jain (1981) for a general discussion, and Hirschman and Guest (1990), Castro Martín and Juárez (1995), and Ainsworth, Beegle and Nyamete (1996) for surveys of recent evidence for Southeast Asian, Latin American, and Sub-Saharan African countries, respectively.

[11]See, for instance, Pritchett (2001).

[12]In this regression, the change effect is *additional* to the level effect. The reason for incorporating these two effects separately is to allow for a temporal dynamic in the effects of changes in the degree of economic freedom: two countries might have the same *average* EFW index over some period, even though it is increasing in one country and decreasing in the other one. If so, one would expect the first country to have a better growth performance, and the empirical results confirm this

EFW index is a composite of several different indicators. Many of these elements amount to measures of price distortions resulting from misguided government policies, which can be expected to affect output growth through their effects on resource allocation—inflation rates, taxes, public spending, government enterprises and state-directed investment, tariff protection and non-tariff trade barriers, price controls, labor and credit market distortions, etc.—so it is possible that one main line of causation runs through the effects of economic freedom on the overall level of efficiency. However, it is also possible that the EFW index affects growth indirectly through effects on some other explanatory variable. It certainly seems plausible to assume, for instance, that greater economic freedom provides more incentives and a better "investment climate." Therefore, it is theoretically interesting to determine whether the main growth-effect of economic freedom is through a direct "efficiency effect" on overall productivity, or through an indirect "incentive effect" on investment. (Of course, these effects are not contradictory in any way, and they might both be present.) The issue is also important empirically, since if the main effect is through the investment rate, this would pose an estimation problem for the regressions in Table 2—in fact, it would not make much sense to include *both* INV and EFW as regressors in that case. Dawson (1998) has outlined some of the statistical implications of this issue for empirical growth analysis:

> *First, if institutions are the primary factor driving cross-country differences in investment, it is redundant to include both investment and an institutional measure as regressors in a cross-country [growth-regression]. One should, however, observe a strong relationship between institutions [i.e., the EFW index] and investment in this case, and the relationship between institutions and growth should strengthen, in a statistical sense, if investment is omitted as a conditioning variable. Second, if factors other than institutions also contribute to cross-country variation in investment or if the effect of institutions operates partially outside the investment channel, the inclusion of an institutions variable should attenuate the size and significance of the estimated coefficient on investment to the extent that the investment channel is operative. Elimination of investment as a conditioning variable would not be appropriate in this case, however, as important information would presumably be lost …. if institutions influence growth primarily through an effect on total factor productivity, measures of both investment and institutions should be statistically significant …. In summary, if institutions operate predominantly through the investment channel, measures of freedom will have little or no explanatory power if the saving rate is already included as an explanatory variable in cross-country regressions. If institutions work primarily through a direct effect on factor productivity, however, including a measure of freedom in a growth regression can be expected to add explanatory power. If institutions work through both channels simultaneously, the inclusion of an institutions variable as a regressor should add explanatory power and reduce the estimated size and significance of investment's impact on growth* (pp. 605-06).

By these criteria, the results clearly support the hypothesis of a "productivity effect" (EFW and DEFW are significant in every regression), but do not seem to favor the "investment channel" as a main line of influence, since the coefficients for INV are pretty much the same in Regression 3 as in Regressions 5 and 9. Moreover, there does not seem to be any

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intuition. Of course, the change effect is a temporary, one-time affair, which will last as long as the country's EFW index continues to increase (which presumably must reach some limit), whereas the level effect is permanent.

strong positive relationship between the investment rate and economic freedom in the 1980-99 sample period.[13] Therefore, it seems likely that the "efficiency effect" is the main causal link between the EFW index and economic growth. Some further light on this issue is provided by Regression 10, which replaces INV with an interaction term between INV and EFW (INV*EFW). In this regression, the effect of changes in the investment rate is now conditional on the value of EFW: each one point increase in the EFW index increases the impact of a one point increase in INV by about 0.016 percentage points. Thus, other things equal, if the investment rates in two countries differ by 10 points (say, 10 and 20 % of GDP), on average their annual growth rates would differ by about 1.6 percentage points if EFW = 10 (very high economic freedom), but only by about 0.16 percentage points if EFW = 1 (very low economic freedom). Notice that EFW has an independent effect of its own in Regression 10, which implies that not all of its effect occurs through effects on investment productivity.[14] The coefficients for the other variables are quite similar to those in Regression 9, and the explanatory power is practically the same in both regressions, so there is not much reason for preferring one over the other on purely statistical grounds, though Regression 10 seems theoretically more appealing since it allows for changes in the productivity of investment as a function of economic freedom.[15] It certainly makes sense to assume that any given level of investment will have a smaller growth impact in countries with lower degrees of economic freedom.[16] The "productivity of investment" effect might

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[13]See Figure 1. The weak relationship shows up even if INV is regressed on *both* EFW and DEFW:

INV = 10.79 + 1.647 EFW + 1.246 DEFW
(3.868) (3.371) (2.129)

adj R^2 = 0.120 N = 92 White test = 6.422 (p = 0.267)

Though the estimated coefficients are both positive and significant, the explanatory power of this regression is quite low.

[14]The coefficient for EFW in Regression 10 is lower than in Regression 9, but these coefficients cannot be compared directly because in Regression 10 the effect of a unit change in EFW is conditional on INV, and now equals 0.424 + 0.0157*INV. The mean value for INV is 21.1 % of GDP for the 80 countries in the sample for Regressions 9 and 10 (for the 106 country sample it is 21.5 %). For this value of INV, the effect of a unit change in EFW would be 0.755, which is actually quite close to the estimated coefficient for EFW in Regression 9.

[15]Gwartney and Lawson (2004), using a slightly different methodology, also explore this issue.

[16]Perhaps the most extreme case in this regard is that of the former Soviet Union, which had one of the highest investment rates in the world, but very low productivity to show for it. On the characteristics of Soviet economic growth see Ofer (1987) and Ericson (1990). In interpreting historical trends in the Soviet economy, an important caveat should also be borne in mind: we nowadays measure a country's wealth by its "Gross Domestic Product," but we tend to forget that this does not consist exclusively of consumption goods, so a high GDP growth rate does not necessarily imply an improvement in the provision of consumer goods, which is ultimately what matters for consumer welfare. The Soviet economy, for instance, had high rates of "economic growth" for several decades, but in practice the greater share of increased production consisted of capital goods, which were reinvested in the productive process, with very little improvement in

even explain the low correlation between the investment rate and the level of economic freedom. There is no theoretically compelling reason to assume that higher investment productivity will necessarily lead to higher *rates* of investment. It might happen in some countries, but other countries might prefer to enjoy the benefits of economic freedom by actually investing less, and consuming more, since any given growth objective could be achieved with less investment, the higher the degree of economic freedom. Presumably, this will depend on the prevailing rates of time preference, which probably differ greatly across countries. This situation is analogous to the role of income and substitution effects in analyzing the effects on labor supply of an increase in wage rates: some countries might prefer to invest less if the productivity of investment rises, just as some people might actually work less when wages rise if preference for leisure is very high.

(6) TROPICAR — The coefficient on this variable confirms the presence of a geographic effect on growth rates during the sample period. Tropical countries do seem to have a disadvantage, even controlling for other relevant variables, and the reasons for this effect are probably due to the factors stressed in the literature on this issue (Gallup, Sachs and Mellinger, 1999; Sachs, 2000). The estimated coefficient implies that, other things equal, a tropical country will have a lower growth rate than a non-tropical country, the penalty for "tropicality" amounting to an average difference of about 1 percentage point in the annual growth rate of per capita GDP.

6. Conclusions.

This study has drawn on a large body of previous theoretical and empirical work, in order to provide a framework for the analysis of growth rates in a broad cross-section of the world economy during the last two decades of the 20th century. We should now recapitulate our main findings and summarize the conclusions that derive from them:

(1) Conditional convergence, as predicted by the Solow model, is present in the 1980-99 data, and seems to be a fundamental aspect of the underlying growth process. Other things equal, a country's growth rate will tend to decline as its per capita income rises, and this factor must be taken into account in any empirical growth analysis.

(2) High population growth, as measured by the fertility rate, has a negative effect on economic growth. The worldwide trend over the past few decades has been in the direction

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living standards. Worse still, the high investment rate did not result in major productivity increases, so to sustain the same rate of economic growth the Soviet economy required much higher investment rates than would have been required in more efficient economies. What is not altogether clear, however, is whether we should interpret as "economic growth" an increase in the production of goods that are devoted exclusively to the maintenance of the productive system itself (losing sight of the fact that, ultimately, the *raison d' être* of the productive system is the provision of consumer goods). Western economists had long been aware of this problem—see, for instance, Nutter (1959, 1968). In any case, there is no reason why investment should be valued for its own sake, and there is nothing intrinsically valuable about a high investment rate *per se*. What ultimately matters for consumer welfare is the level of consumption, and though investment is important for economic growth, both investment and growth are desirable only to the extent that they enable higher levels of consumption.

of declining fertility levels, but they still remain quite high in many less developed countries. A continuation of this trend would provide some grounds for optimism regarding the prospects for growth in low-income countries. Countries that maintain persistently high population growth, however, will be at a disadvantage in terms of per capita income growth.

(3) Investment in physical capital is important, and countries that save/invest a large share of GDP will grow faster than countries that save/invest little.

(4) Human capital is also important for economic growth, and here too there is much scope for improvement. In 1995 the average level of the Barro-Lee educational attainment measure ("average years of schooling for the population aged 15 or over") was about 6 years per adult, with a median value of 5.82 years. In other words, in half of the countries surveyed, the average adult had not completed primary education. Major improvements in this area can be expected to boost per capita income growth in less developed countries in the foreseeable future, and should remain a priority for development policy planners.

(5) Perhaps the most important conclusions of this study relate to the role of economic freedom. Higher degrees of economic freedom, as measured by the EFW index, are associated with higher rates of economic growth. The main channel of influence appears to be through a direct "productivity effect," since many of the components of the EFW index amount to measures of price distortions, which can be expected to affect economic growth through their effects on efficiency in the allocation of resources. An indirect "incentive effect" via the investment rate may also be present, but the evidence is less clear on this point (though there does appear to be a strong positive relationship between economic freedom and the *productivity* of investment).

(6) Geography is a factor that should be taken into account in explaining cross-country variations in growth rates, since tropical countries are at a disadvantage in terms of economic growth. This pessimistic conclusion, however, should be tempered by a healthy dose of pragmatism: geographic location is a unalterable fact, and there is nothing that can be done about it, though much can be done in terms of the other determinants of economic growth. The penalty for "tropicality" can be overcome, for instance, by promoting policies that increase the level of economic freedom. In tropical countries, therefore, the case for economic freedom is even stronger than in non-tropical countries.[17]

Finally, though these variables explain a large share of the observed cross-country variation in growth rates, a significant portion of this variation (over 20 %) remains unexplained. Some part of this, no doubt, is due to measurement error, and country-specific factors also play some role. No *general* explanatory model can ever hope to explain 100 % of the observed variation over any given period, though there are probably many other systematic factors at work which need to be explored. There is still plenty of scope for further research in this field.

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[17]In this regard, it seems worthwhile to point out that some of the most rapidly growing economies of the past half century are located in the tropics: Singapore and Malaysia almost precisely on the equator, and Taiwan and Hong Kong on the Tropic of Cancer. Regarding the case of Taiwan, see Tsiang (1984) and Lau (1990).

Figure 1 — Investment rate vs. EFW index, 92 countries, 1980-99
(countries are listed in Appendix B)

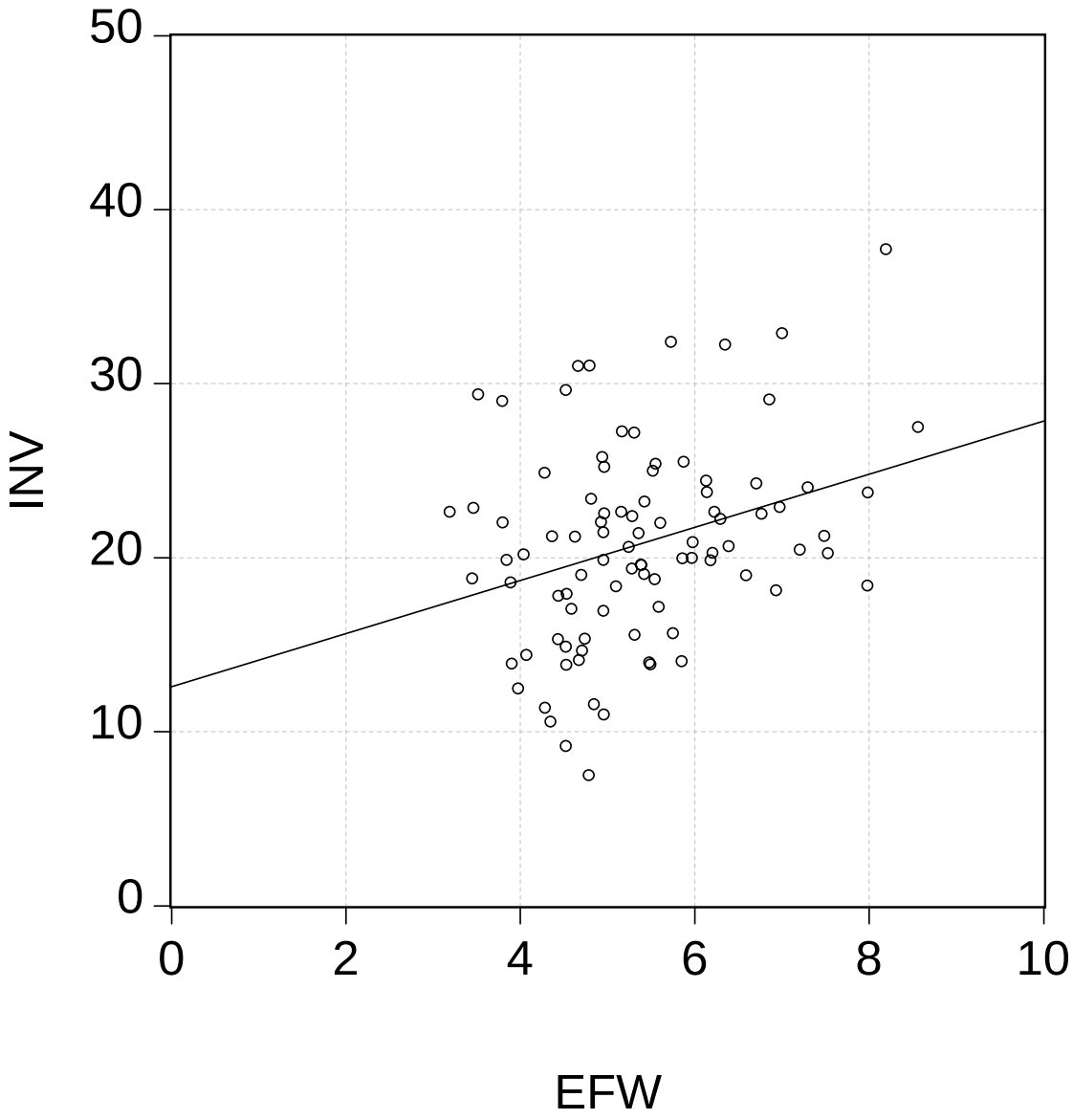

Table 2 – Determinants of Economic Growth, 1980-99: Regression Results.

Dependent Variable: Average annual rate of growth (%), real per capita GDP, 1980-99.

Regression Number:	[1]	[2]	[3]	[4]	[5]
Explanatory Variables:					
Constant	**14.604** [5.559]	**14.436** [5.517]	**14.498** [5.585]	**12.945** [4.720]	**11.669** [4.996]
LOGGDP80	**-1.433** [-5.831]	**-1.422** [-5.813]	**-1.429** [-5.892]	**-1.729** [-6.015]	**-1.752** [-8.007]
INV	**0.076** [3.035]	**0.083** [3.271]	**0.081** [3.309]	**0.091** [2.898]	**0.084** [3.288]
FERTIL	**-1.203** [-7.859]	**-1.204** [-7.905]	**-1.205** [-7.957]	**-1.093** [-6.971]	**-1.002** [-7.251]
DSCH15	**0.531** [2.868]				
DMALESCH15		**0.590** [2.324]	**0.527** [3.193]	**0.551** [2.963]	**0.521** [3.649]
DFEMSCH15		**-0.090** [-0.328]			
EFW				**0.599** [3.479]	**0.761** [5.490]
DEFW					**0.461** [3.616]
Adjusted R-squared	**0.587**	**0.591**	**0.596**	**0.685**	**0.726**
N	**90**	**90**	**90**	**85**	**85**
White test (chi-square)	**5.030**	**29.622**	**9.317**	**35.940**	**38.830**
d.f. for White test	**14**	**20**	**14**	**20**	**27**
prob-value	**0.985**	**0.076**	**0.810**	**0.016**	**0.066**

(cont.)

Table 2 (cont.)

Dependent Variable: Average annual rate of growth (%), real per capita GDP, 1980-99.

Regression Number:	[6]	[7]	[8]	[9]	[10]
Explanatory Variables:					
Constant	**4.666** [1.147]	**1.604** [0.408]	**12.748** [4.550]	**13.675** [6.170]	**15.877** [7.923]
LOGGDP80	**-0.449** [-1.374]	**-1.159** [-3.067]	**-1.970** [-9.056]	**-1.988** [-9.459]	**-1.991** [-9.492]
INV			**0.088** [3.551]	**0.089** [3.659]	
INV*EFW					**0.0157** [3.679]
FERTIL			**-0.913** [6.524]	**-0.926** [-6.951]	**-0.937** [-7.122]
DSCH15					
DMALESCH15			**0.317** [2.198]	**0.337** [2.438]	**0.332** [2.399]
DFEMSCH15					
EFW		**1.245** [7.007]	**0.811** [5.826]	**0.797** [5.915]	**0.424** [2.339]
DEFW		**0.715** [3.955]	**0.495** [3.957]	**0.513** [4.277]	**0.513** [4.280]
TROPICAR	**-2.148** [-3.767]	**-2.333** [-4.132]	**-1.219** [-3.351]	**-1.098** [-3.695]	**-1.196** [-4.006]
POP100KM	**2.095** [3.768]	**1.293** [2.462]	**0.140** [0.368]		
LOGDIST	**-0.007** [-0.033]	**0.217** [1.047]	**0.091** [0.552]		
Adjusted R-squared	**0.206**	**0.509**	**0.773**	**0.778**	**0.779**
N	**96**	**87**	**80**	**80**	**80**
White test (chi-square)	**27.753**	**48.996**	**66.422**	**44.942**	**42.987**
d.f. for White test	**14**	**27**	**54**	**35**	**35**
prob-value	**0.015**	**0.006**	**0.119**	**0.121**	**0.166**

Note: All of the regressions were estimated by ordinary least squares. Numbers in brackets are *t*-values of the estimated coefficients. For regressions 4, 6 and 7 *t*-values were estimated using the White (1980) correction.

APPENDIX A — DATA DEFINITIONS AND SOURCES

(Basic data for this study are contained on an Excel spreadsheet, available upon request to: jhcole@ufm.edu.gt .)

(a) *Sources*

1) Economic and population variables: *World Development Indicators*, 2001 (CD-ROM version). This source reports data for 207 countries, though coverage for some of them is rather limited. For this study, the basic sample is restricted to countries for which figures are available on real GDP per capita for the years 1980 and 1999 (thus allowing calculation of a rate of growth of real per capita GDP over that sample period). This sample is reduced further to 106 countries for which full data are available on variables required for Regression 1 and/or Regression 6.

2) Educational Attainment: Barro and Lee (1996, 2001), dataset downloaded from http://www2.cid.harvard.edu/ciddata/barrolee/Appendix.xls.

3) Economic Freedom of the World Index: James Gwartney and Robert Lawson, "Chain-linked Adjusted Summary Index," Madrid Meeting of Economic Freedom Network (Oct 2002). Dataset provided by Prof. Lawson. See Appendix B for the full listing of countries.

4) Geographic variables: Gallup, Sachs and Mellinger (1999), dataset downloaded from http://www2.cid.harvard.edu/ciddata/geodata.csv.

(b) *Data Definitions*

For each country, an effort has been made to obtain figures for as many of the following variables as possible:

GDP1980 = PPP-adjusted GDP per capita, in international dollars, 1980.

GROWTH8099 = average annual growth rate of real GDP per capita, 1980-99. This is the dependent variable for the econometric analyses.

INV = Investment/GDP ratio (Gross Fixed Capital Formation as % of GDP), average for 1980-99.

FERTIL = Total fertility rate (births per woman), average for 1980-99.

(An effort has been made to compute these averages using all annual values over the full sample period. However, for some countries there are missing data in some years. In every case, the average has been computed using all available annual data over the sample period.)

POPGROWTH = average annual population growth rate, 1980-99, based on total population figures for 1980 and 1999.

SCH15 = Average years of schooling for the total population aged 15 and over, 1980 and 1995.

FEMSCH15 = Average years of schooling for the female population aged 15 and over, 1980 and 1995.

MALESCH15 = Average years of schooling for the male population aged 15 and over, 1980 and 1995.[18]

EFW [year] = Economic Freedom of the World Index, a number ranging from 1 (low freedom) to 10 (high freedom). Chain-linked adjusted summary index, for the years 1980, 1985, 1990, 1995 and 2000.

TROPICAR = proportion (0 to 1) of the country's territory located in the geographic tropics (defined as areas located between 23.5 degrees of latitude North and 23.5 degrees of latitude South).

POP100KM = proportion (0 to 1) of the country's population living within 100 kilometers of the sea coast.

AIRDIST = minimum Great-Circle (air) distance, in kilometers, from the country to one of three core areas of the world economy (defined as NewYork, Rotterdam or Tokyo).

[18]Figures on male schooling for 1980 and 1995 were derived from data on total and female schooling using the formula MALESCH = 2*SCH – FEMSCH.

APPENDIX B — ECONOMIC FREEDOM OF THE WORLD INDEX (2000)

The following table lists 123 countries covered by the EFW index as of 2000, ranked according to their value for the index in that year.

Rank	Country	EFW Index	Rank	Country	EFW Index
1	Hong Kong (*)	8.78	42	Botswana (*)	6.96
2	Singapore (*)	8.57	43	Czech Rep.	6.84
3	United States (*)	8.53	44	Peru (*)	6.82
4	United Kingdom	8.35	45	Greece (*)	6.82
5	Switzerland (*)	8.21	46	Dominican Rep. (*)	6.77
6	New Zealand	8.20	47	Israel (*)	6.74
7	Ireland (*)	8.13	48	South Africa (*)	6.73
8	Canada (*)	8.10	49	Bolivia (*)	6.69
9	Netherlands (*)	7.98	50	Latvia	6.66
10	Australia (*)	7.98	51	Egypt (*)	6.66
11	Iceland (*)	7.70	52	Malaysia (*)	6.66
12	Luxembourg	7.65	53	Uruguay (*)	6.65
13	Finland (*)	7.63	54	Thailand (*)	6.64
14	Denmark	7.61	55	Hungary (*)	6.56
15	Germany	7.61	56	Kenya (*)	6.54
16	Unit. Arab Em.	7.56	57	Nicaragua (*)	6.45
17	Chile (*)	7.49	58	Uganda	6.43
18	Belgium (*)	7.44	59	Malta	6.38
19	Austria (*)	7.42	60	Bahamas	6.38
20	Sweden (*)	7.36	61	Lithuania	6.37
21	Spain (*)	7.31	62	Guatemala (*)	6.34
22	Mauritius (*)	7.31	63	Haiti (*)	6.31
23	Japan (*)	7.30	64	Zambia (*)	6.31
24	Bahrain	7.29	65	Paraguay (*)	6.31
25	Portugal (*)	7.29	66	Honduras (*)	6.30
26	Panama (*)	7.27	67	Namibia	6.27
27	Oman	7.26	68	Belize	6.22
28	Costa Rica (*)	7.25	69	Mexico (*)	6.15
29	Norway (*)	7.24	70	Cyprus (*)	6.14
30	El Salvador (*)	7.20	71	India (*)	6.11
31	Jordan (*)	7.20	72	Sri Lanka (*)	6.07
32	Argentina (*)	7.19	73	Tunisia (*)	6.06
33	Taiwan	7.18	74	Guyana (*)	6.05
34	Trinidad & Tob. (*)	7.15	75	Fiji (*)	6.02
35	Philippines (*)	7.07	76	Slovenia	6.01
36	Italy (*)	7.06	77	Cote d'Ivoire (*)	5.98
37	Estonia	7.03	78	Indonesia (*)	5.95
38	Jamaica (*)	6.99	79	Morocco (*)	5.92
39	Kuwait	6.98	80	Pap. New Guinea (*)	5.89
40	South Korea (*)	6.97	81	Slovak Rep.	5.89
41	France (*)	6.97	82	Senegal (*)	5.81

Rank	Country	EFW Index
83	Tanzania	5.79
84	Venezuela (*)	5.78
85	Poland	5.74
86	Turkey (*)	5.73
87	Benin (*)	5.66
88	Mali (*)	5.65
89	Nepal (*)	5.65
90	Ghana (*)	5.62
91	Brazil (*)	5.60
92	Barbados (*)	5.55
93	Colombia (*)	5.53
94	Niger (*)	5.48
95	Croatia	5.46
96	Albania	5.46
97	Pakistan (*)	5.46
98	Bangladesh (*)	5.45
99	Cameroon (*)	5.42
100	China (*)	5.40
101	Nigeria (*)	5.37
102	Bulgaria	5.34
103	Chad (*)	5.32
104	Gabon (*)	5.27
105	Ecuador (*)	5.25
106	Madagascar (*)	5.20
107	Sierra Leone (*)	5.20
108	Burundi (*)	5.14
109	Iran (*)	5.08
110	Togo (*)	5.03
111	Syria (*)	4.96
112	Congo, Rep. of (*)	4.92
113	Central Afr. Rep. (*)	4.87
114	Zimbabwe (*)	4.79
115	Romania (*)	4.74
116	Rwanda (*)	4.61
117	Malawi (*)	4.50
118	Russia	4.49
119	Ukraine	4.49
120	Algeria (*)	4.22
121	Guinea-Bissau	4.10
122	Congo, Dem. Rep.	3.67
123	Myanmar	3.37

(*) Included in Regressions 4 and/or 7, and in Figure 1. Not all countries could be included in the analysis, due to data limitations: (1) most Communist and ex-Communist countries (including unified Germany) lack consistent national accounts data for the full sample period, (2) some countries lacked data for the schooling and/or geographic variables, (3) national accounts data were not available for Taiwan from standard official sources. Regressions 1 and/or 6 also include 11 countries not covered by the EFW (Burkina Faso, Dominica, Gambia, Lesotho, Mauritania, Mozambique, Saudi Arabia, St. Kitts/Nevis, St. Lucia, St. Vincent/Grenadines and Swaziland) and 3 countries which do not have EFW values for the full sample period (Latvia, Guinea-Bissau and Namibia).

REFERENCES

Ainsworth, M., Beegle, K. and Nyamete, A. (1996), "The Impact of Women's Schooling on Fertility and Contraceptive Use: A Study of Fourteen Sub-Saharan African Countries," *World Bank Economic Review*, **10**: 85-122.

Barro, R. J. (1994), *Economic Growth and Convergence*, Occasional Papers No. 46. San Francisco, International Center for Economic Growth.

——— (2001), "Human Capital and Growth," *American Economic Review*, **91**: 12-17.

Barro, R. J. and Lee, J.-W. (1994), "Losers and Winners in Economic Growth," in *Annual Conference on Development Economics 1993*, pp. 267-97. Washington, World Bank.

——— (1996), "International Measures of Schooling Years and School Quality," *American Economic Review*, **86**: 218-23.

——— (2001), "International Data on Educational Attainment: Updates and Implications," *Oxford Economic Papers*, **53**: 541-63.

Barro, R. J. and Sala-i-Martin, X. (1992), "Convergence," *Journal of Political Economy*, **100**: 223-51.

Castro Martín, T. and Juárez, F. (1995), "The Impact of Women's Education on Fertility in Latin America: Searching for Explanations," *International Family Planning Perspectives*, **21**: 52-57.

Coale, A. J. (1983), "Recent Trends in Fertility in Less Developed Countries," *Science*, **221**: 828-32.

Crenshaw, E. M., Ameen, A. Z. and Christenson, M. (1997), "Population Dynamics and Economic Development: Age-Specific Population Growth Rates and Economic Growth in Developing Countries, 1965 to 1990," *American Sociological Review*, **62**: 974-84.

Dawson, J. W. (1998), "Institutions, Investment and Growth: New Cross-Country and Panel Data Evidence," *Economic Inquiry*, **36**: 603-19.

Easton, S. T. and Walker, M. A., eds. (1992), *Rating Global Economic Freedom.* Vancouver, Fraser Institute.

——— (1997), "Income, Growth, and Economic Freedom," *American Economic Review*, **87**: 328-32.

Ericson, R. E. (1990), *The Soviet Union, 1979-1990*. Country Studies No. 7. San Francisco, International Center for Economic Growth.

Gallup, J. L., Sachs, J. D. and Mellinger, A. D. (1999), "Geography and Economic Development," in *Annual World Bank Conference on Development Economics 1998*, pp. 127-70. Washington, World Bank.

Gwartney, J. D., Block, W. E. and Lawson, R. A. (1996), *Economic Freedom of the World: 1975-1995.* Vancouver, Fraser Institute.

Gwartney, J. D. and Lawson, R. A. (2002), *Economic Freedom of the World—2002 Annual Report*, Vancouver, Fraser Institute.

——— (2003), "The Concept and Measurement of Economic Freedom," *European Journal of Political Economy*, **19**: 405-30.

——— (2004), "What Have We Learned from the Measurement of Economic Freedom?", in *The Legacy of Milton and Rose Friedman's "Free to Choose": Economic Liberalism at the Turn of the 21st Century*, pp. 217-38. Dallas, Texas: Federal Reserve Bank of Dallas.

Hirschman, C. and Guest, P. (1990), "The Emerging Demographic Transitions of Southeast Asia," *Population and Development Review*, 16: 121-52.

Jain, A. K. (1981), "The Effect of Female Education on Fertility: A Simple Explanation," *Demography*, **18**: 577-95

Kelley, A. C. (1988), "Economic Consequences of Population Change in the Third World," *Journal of Economic Literature*, **26**: 1685-1728.

Knight, M., Loayza, N. and Villanueva, D. (1993), "Testing the Neoclassical Theory of Economic Growth," *IMF Staff Papers*, **40**: 512-41.

Knodel, J., Havanon, N. and Sittitrai, W. (1990), "Family Size and the Education of Children in the Context of Rapid Fertility Decline," *Population and Development Review*, **16**: 31-62.

Lau, L. J., ed. (1990), *Models of Development: A Comparative Study of Economic Growth in South Korea and Taiwan*. San Francisco, International Center for Economic Growth.

Leamer, E. (1975), "A Result on the Sign of Restricted Least-Squares Estimates," *Journal of Econometrics*, **3**: 387-90.

Mankiw, N. G., Romer, D. and Weil, D. N. (1992), "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, **107**: 407-37.

Maudlin, W. P. (1981), "Patterns of Fertility Decline in Developing Countries, 1950-75," in N. Eberstadt, ed., *Fertility Decline in the Less Developed Countries*, pp. 72-96. New York, Praeger.

Nutter, G. W. (1959), "The Structure and Growth of Soviet Industry," *Journal of Law and Economics*, **2**: 147-74.

——— (1968), "The Soviet Economy: Retrospect and Prospect," in M. M. Drachkovitch, ed., *Fifty Years of Communism in Russia*, pp. 75-98. University Park, Pennsylvania State University Press.

Ofer, G. (1987), "Soviet Economic Growth: 1928-1985," *Journal of Economic Literature*, **25**: 1767-1833.

Pritchett, L. (2001), "Where Has All the Education Gone?" *World Bank Economic Review*, **15**: 367-91.

Sachs, J. D. (2000), "Tropical Underdevelopment," CID Working Paper No. 57. Center for International Development, Harvard University.

Sala-i-Martin, X. (1996), "The Classical Approach to Convergence Analysis," *Economic Journal*, **106**: 1019-36.

Sarel, M. (1995), "Demographic Dynamics and the Empirics of Growth," *IMF Staff Papers*, **42**: 398-410.

Solow, R. M. (1956), "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics*, **70**: 65-94.

Tsiang, S. C. (1984), "Taiwan's Economic Miracle: Lessons in Economic Development," in A. C. Harberger, ed., *World Economic Growth*, pp. 301-25. San Francisco, ICS Press.

White, H. (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica*, **48**: 817–38.

Wilson, C. (2001), "On the Scale of Global Demographic Convergence, 1950-2000," *Population and Development Review*, **27**: 155-71.